CONNECTION SYSTEM FOR STEEL CONSTRUCTION

Cross-Reference to Related Application

This application claims the priority of U.S. Provisional Application Serial No. 60/149,414, filed on August 17,1999

Background of the Invention

This invention relates generally to connectors and connection systems for light gauge steel construction and the like. More particularly, this invention relates to methods and fastening systems employed for connecting light gauge steel employed in the construction trades for housing and structures and the like.

In conventional systems to which the invention relates, load distribution codes in light steel connections are entirely satisfied by the use of screws. In such conventional systems, numerous screws or fasteners are required to provide the connection, and self-drilling screws are preferred.

Brief Summary of the Invention

The present invention takes a novel approach by providing a light gauge steel connection having an enhanced load bearing capacity through the use of both fasteners and a structural adhesive. By using a structural adhesive, the number of required fasteners is significantly decreased while the load bearing capacity and durability of the connection is increased.

The application can be employed with numerous mechanical fasteners such as self-drilling screws, pins, rivets and clinches. The adhesive is preferably a two-part epoxy adhesive system with a one to one metered mix formulation which cures at room temperature and has a very high viscosity.

Brief Description of the Drawings

Figure 1(a) is a schematic representational view of a prior art fastening system connecting a steel stiffening strap in a shear wall application with gusset plates;

Figure 1(b) is a schematic representational view illustrating, by contrast with Figure 1(a), the connection system of the present invention;

Figure 1(c) is a fragmentary sectional view of the connection system of 1(b) taken along the line c-c thereof;

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Figure 2 is a schematic representational diagram illustrating a prior art connection system for 20 gauge steel strips which are connected with a four square inch overlap by screw fasteners in accordance with the prior art connection system;

Figure 3 is a schematic representational diagram for 20 gauge steel strips with a four square inch overlap which are connected by screw fasteners and adhesive in accordance with the connection system of the present invention;

Figure 4 is a hysteresis graph illustrating a push/pull deflection test for a single sided 18 gauge steel diaphragm wall employing No. 14 screws for fastening;

Figure 5 is a hysteresis graph illustrating a push/pull deflection test for an 18-gauge steel diaphragm wall employing No. 14 screws and an adhesive bonding system for fastening in accordance with the present invention;

Figure 6 is a hysteresis graph illustrating a push/pull deflection test for a single sided 22 gauge steel diaphragm wall employing No.14 screws for fastening the panel;

Figure 7 is a hysteresis graph illustrating a push/pull deflection test for a single sided 22 gauge steel diaphragm wall employing No. 14 screws and an adhesive bonding system for fastening in accordance with the present invention;

Figure 8 is a schematic representational diagram illustrating one embodiment of the invention;

Figure 9 is a schematic representational diagram illustrating a prior art connection system for 20 gauge steel strips which are connected with a four square inch overlap by pin fasteners in accordance with the prior art connection system; and

Figure 10 is a schematic representational diagram for 20 gauge steel strips with a four square inch overlap which are connected by pin fasteners and adhesive in accordance with the connection system of the present invention;

Detailed Description of the Preferred Embodiments

The invention is schematically illustrated by Figures 1(a) and 1(b) which contrast the conventional design (Figure 1(a)) with the adhesive/fastener design of the present invention (Figure 1(b)). With reference to Figure 1(a), a conventional stiffening strap 12 is illustrated in a shear wall application with gusset plates 14. Numerous fasteners 20 are required.

By contrast, the present invention, which employs both an adhesive 10 and fasteners 20, dramatically reduces the number of required fasteners (schematically illustrated) while enhancing the load bearing capacity and integrity of the connection.

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The adhesive 10 which is employed in the system is selected so as to have a high shear and peel strength, room temperature curing and easy application characteristics at room temperature. The adhesive is also tough, does not fail adhesively under loads and is capable of adhering to as-received galvanized steel. The adhesive 10 may be applied to the metal panel 30 and/or the support structure 40, such as a stud, by a hand operated or automatic dispensing device 16.

In one embodiment of the invention, the adhesive 10 fully cured at room temperature within 72 hours. One acceptable adhesive employed in the invention is an adhesive sold as Formulation No. 12059A marketed by the Advanced Adhesive Systems, Inc., of Newington, Connecticut. The adhesive is a two part epoxy system having a substantially 1:1 resin/hardener mix by weight or volume which has a very high viscosity and cures at room temperature. This formulation upon curing has a Shore D of 40-45 and an operating temperature range of –40° F to 250° F. The adhesive 10 may also be another room temperature or heat activated adhesion system such as a methacrylate, urethane, etc.

With reference to Figure 8, in accordance with one embodiment of the invention, the adhesive is applied to one or both of the steel surfaces to form beads 32 and/or 42. The other panel 30 is placed in an overlapping relationship against the stud 40. Self-drilling fasteners 20 are then inserted through the panels by power driver 24 and the adhesive is compressed between the panel 30 and the stud 40. The fasteners 20 are preferably Metaltite self-drilling metal panel fasteners (disclosed in U.S. Patent No. 5,304,023 assigned to Metaltite Corporation of West Hartford, Connecticut) because of their high resistance to pull-out. The adhesive is then allowed to cure.

The integrity of the adhesive/fastener connection system was demonstrated by lap-joint shear tests conducted on 20 gauge, as received, steel strips 50 and 52 which were connected with a four square inch overlap. Figure 2 illustrates the integrity of the connection for various configurations wherein screws 20 only were employed. These connections were tested in shear with the corresponding quantities at the bottom illustrating the failure point of the connection in pounds. A side view illustrating the lap-joint and schematically representing the shear loading is at the extreme right of Figure 2. When an adhesive 10 was also applied, the tests were repeated, and the results are illustrated in Figure 3. A side view illustrating the lap joint and schematically representing the shear loading is at the extreme right of Figure 3. It will be appreciated that the joint integrity was significantly enhanced.

Figures 4-7 illustrate the effect of push-pull cyclic loading on 4' X 8' light gauge steel panels assembled to steel studs with only fasteners and with an adhesive/fastener combination. The resulting assembly is referred to as a "single sided diaphragm wall."

The push-pull cyclic load is applied to the top of the wall at 5 seconds per cycle. The resulting top-of-the-wall deflection is measured and plotted against the push-pull load. The resulting graphs show top-of-the-wall deflection lagging the applied load. The retardation of the effect when the forces acting upon a body are changed is defined as hysteresis. Push-pull tests were conducted under substantially equivalent conditions for the results of Figures 4-7. These hysteresis graphics demonstrate favorable test results for the adhesive/fastener connection system in accordance with the present invention. In comparison to connection systems which employ screws without adhesive, the results show superior adhesive and connection characteristics per fastener.

Figure 4 is a hysteresis graph of a single sided 18-gauge steel diaphragm wall assembled with No.14 self-drilling panel screws. The vertical axis is the applied load on top of the wall. The units are thousand pounds per square inch. The horizontal axis represents the top-of-the-wall deflection in inches.

Figure 5 shows the same 18-gauge steel diaphragm wall wherein No 1 self-drilling panel screws were fastened to connect the panels to the frame, and in addition, a prototype adhesive was applied at the perimeter and the center of the studs.

Figure 6 shows a hysteresis graph for a single sided 22 gauge steel panel wherein No. 14 self-drilling panel screws fasten the panel to the frame.

Figure 7 shows a hysteresis graph for the panel of Figure 6 where, in addition, a prototype adhesive at the perimeter and the center of the studs was applied.

It should be appreciated that the hysteresis graphs clearly demonstrate that there is a superior connection by usage of the adhesive and the self-drilling screws.

The invention may also be employed with other mechanical fasteners such as screws of various types, pins, rivets and clinches. The invention may also be used with types of numerous support structures such as steel and metal studs, non-metallic studs, framing, FRP plastics panel and plywood panel, etc.

With reference to Figures 9 and 10, the integrity of the adhesive/fastener connection system was demonstrated for pins by lap-joint shear test conducted on 20 gauge, as received, steel strips 50 and 52, which were connected with a four inch square overlap in a manner similar to that described for Figures 2 and 3.

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Figure 9 illustrates the integrity of the connection for configurations wherein pins 22 only were employed. The pins 22 had a diameter of 0.100 inch and were driven by a pneumatic driver. These connections were then tested in shear with corresponding quantities at the bottom of the figure illustrating the failure point of the connection in pounds. When the adhesive 10, which was a two-part epoxy system, was also applied, the tests were repeated, and the results are illustrated in Figure 10, wherein the failure point in pounds is indicated at the bottom. It should be appreciated that the joint integrity was significantly enhanced when both the adhesive and pins were employed as contrasted with the pins only.

While the foregoing description sets forth a preferred embodiment of the invention, the foregoing description should not be deemed a limitation of the invention herein. Other adaptations, modifications and alternatives may occur to one skilled in the art without departing from the spirit and scope of the present invention.

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